EXPERIMENTS TO TEST THE DIFFUSION OF HYDRO-CYANIC ACID GAS IN FUMIGATING HOUSES.*

A. F. BURGESS.

In February, 1906, a set of fumigation experiments was started to test the diffusion of hydro-cyanic gas in fumigating houses, with the object of determining the rapidity with which this gas diffuses, both in empty houses or boxes and also when they are filled with stock, as would be the case when they are in use. For this purpose permission was secured from the Agricultural Department of the Ohio State University to use a greenhouse in which soil experiments are conducted, and the fumigating box belonging to the Horticultural Department of the same institution was also furnished for the tests.

By placing the box on a truck which run on a track it could be pushed outside the greenhouse. In this way it was thoroughly aired without allowing the fumes to escape in the house and an opportunity was afforded to try several tests out of doors where the temperature was near the freezing point.

Description of Box: The box was lined with galvanized iron and was 4 ft. x 2½ ft. x 10 ft. inside measure, making a capacity of 100 cubic feet.

The cover was hinged at one end and was opened by using a rope and pulley at the other end. It shut on strips of felt, and, as the galvanized iron made the cover rather heavy, it would close very tightly without additional weights. Clamps were used. however, in order to make the box perfectly gas tight.

The generating jar was placed near the end at which the cover was raised, and, in order that no gas might escape while it was being closed, the cyanide was enclosed in tissue paper and dropped by a string through a small hole directly above the jar.

* Read before the meeting of the Ohio State Academy of Science.

As it was necessary to draw samples of air from different parts of the box at intervals during the tests, six holes were made, one at one end of the box, two on the side of the box near the top and bottom, and three in the end opposite the jar; the first near the middle and top of the box, the second half way from the top to the bottom of this end but at one side of the center, and the third near the lower corner. Sections of gas pipe about three inches long were threaded and screwed into the holes, so that about two inches extended outside the box.

The apparatus for drawing the samples to be tested was made by using sections of one-inch glass tubing eighteen inches long. To one end was attached a rubber tube, and a pinch cock was used as a cut off. Another rubber tube provided with a pinch cock was attached to the pipe. The glass tube was then filled with distilled water and attached to the rubber tube leading from the hole, and after opening the upper cock the water was gradually allowed to dribble from the lower rubber tube by partially releasing the other cock. After one foot of water had run from the glass tube, both valves were closed. By uncoupling the glass tube from the upper rubber tube and placing the thumb over the end, the gas caught was easily mixed with the water by shaking. The water solution was then placed in small bottles, which were tightly corked, and after a set of experiments was made samples were taken to the laboratory, placed in test tubes and treated with a solution of silver nitrate.

The presence of hydro-cyanic acid gas was indicated by a white precipitate. In case chlorides were present a similar preciptiate might be secured, hence the distilled water was repeatedly tested before using in order to assure accuracy of results. · ·

No attempt at quantitative analysis was possible, in the limited time that could be devoted to the tests, but the precipitates secured were rated as "trace," "very slight," "slight," "good," "very good," and "heavy," in order to form a basis for determining results.

The writer is aware that the method followed can be improved and trusts that someone may have sufficient time to devote to this important work, in order to secure a more extended knowledge of the behavior of this gas in fumigating under various conditions.

By experiment it was found that the results secured by using a glass tube eighteen inches long were not reliable, as only a small amount of air from the box was obtained. Two tubes were then coupled together so that about two feet of water could be drawn out. This resulted in a fair sample being drawn for each test.

	Test 1		Test 2		Test 3		Test 4		Test 5		Test 6		Test 7		
Hole	Time	Ppt.	Time	Ppt.	Time	Ppt.	Time	Ppt.	Time	Ppt.	Time	Ppt.	Time	Ppt.	Ppt.
A.	5	G.	1	G	5	G.	5	H.	4	T.	4	H.	5	T.	T.
A.	25	H.	11	G.	25	H.	20	G.	26	G.	25	G.	24	G.	S.
B.	7	G.	2	T.	7	G.	6	G.	5	G.	6	S.	7	T.	0
B.	26	V. G.	12	G.	26	V. G.	21	G.	28	G.	26	G.	25	G.	S
C.	15	G.	6	V. S.	15	G.	14	S.	12	G.	15	S.	15	T.	0
C.	36	V. G.	17	G.	36	V. G.	28	G.	35	S.	35	G.	31	T.	0
D.	16	S.	3	G.	16	S.	8	G.	7	T.	9	0	9	S.	S
D.	36	V. S.	13	S.	38	V. S.	23	G.	30	S.	28	S.	27	T.	0
E.	18	G.	7	G.	18	G.	15	G.	14	T.	22	T.	17	T.	0
E.	39	V. G.	19	G.	39	V. G	30	G.	37	S.	37	G.	39	T.	0
F.	8	G.	8	G.	8	G.	16	G.	15	0	23	T.	18	T.	0
F.	28	V. G.	19	G.	28	V. G.	31	G.	39	S.	37	G.	39	T.	0
	P. M. Feb. 22		P. M. Feb. 22 Temp. 80°		P. M. Feb. 22, '06. Temp. 92° Floor of box wet.		Feb. 24 Temp. 80° Floor of box wet.		P. M. Feb. 26 Temp. 72° Box packed with stock. Solution tested after standing 23 hrs.		Feb. 28 Temp. 32° Box full of stock. Treated out of doors		P. M. Feb. 28 Temp. 70° Stock drenched with water Results immediately after finishing Exp.		Results after precipitate stood 17 hours.

Chemicals used: In all tests the 1.1.3. formula was used: *i. e.*, 1 oz. potassium cyanide, 1 fluid oz. sulfuric acid, 3 fluid oz. of water. The cyanide was manufactured by Messrs. Merck & Company, of New York, and was 99% pure, and an excellent grade of commercial sulfuric acid was used.

The table gives the results obtained:

Experiments conducted by Prof. Wilmon Newell in Georgia (Bulletin No. 15, Georgia State Board of Entomology) showed that the violence of the reaction between the cyanide and diluted sulfuric acid subsided at the end of five minutes, and that no gas was evolved after ten minutes, if the cyanide was added so as to be well covered with the liquid.

From the data given in the table it appears that the gas first evolved is driven to the top of the box by the violence of the reaction, and that it passes in waves to the end farthest from the jar. It then seems to gradually permeate the lower parts of the box until thoroughly diffused, but the reactions are less marked in samples taken from the upper hole at the greatest distance from the jar after the box has been closed from thirty to forty minutes.

Results; Tests one and two which were made under normal conditions, the box being dry, showed that the gas was well diffused throughout the box at the end of forty minutes. The poorest results in both tests were shown at hole D at the end of the box opposite the jar. The sample taken three minutes after the charge was "fired" showed a good precipitate, and the amount of precipitate diminished as the time was lengthened. The test at hole E, which was at the same end of the box but several inches lower that hole D, gave an excellent precipitate.

In tests three and four, where the floor of the box was covered with water, practically the same results were secured, although in test four the sample taken at hole D gave a good precipitate.

In test five the box was packed with stock and the temperature was 72°. The results can hardly be considered conclusive, as the precipitate was allowed to stand in corked bottles for twenty-three hours before it was tested. In nearly every case, however, the samples showed a better precipitate the longer the time elapsed before the sample was taken.

Test six showed very similar results, although the box was placed out of doors where the thermometer stood 32°.

In test seven, where the stock was drenched with water, the results were much less satisfactory. A trace of gas was detected in each sample, and in a few slightly better results were noted. The precipitates secured in the test were allowed to stand seventeen hours and the condition is noted in the column adjoining test seven. It will be noted that enough of the precipitate

was redissolved, to make the results unreliable, hence all notes should be made as soon as the tests are completed.

It is also possible to add an excess of silver nitrate, when testing the solution, and if this is done a slight precipitate may be redissolved and inaccurate results obtained.

Summary of Results.

In drawing conclusions as to the rapidity with which the gas will diffuse to different parts of the fumigating box, it should be borne in mind that this will depend somewhat on the violence of the reaction, which will probably differ slightly in every test on account of differences in size in the lumps of cyanide used, the depth to which they are submerged, and the thickness of the paper which is used for wrapping.

In an empty box the gas diffused very rapidly, as is shown in tests one and two, every sample taken indicating its presence. Equally good results were secured when the floor of the empty box was drenched with water.

In the case of the box that was packed with stock it appeared that the diffusion was retarded, but reactions were secured, showing the presence of the gas in all the samples drawn in the longer periods. Very similar results were secured in both tests, and as far as the data in the experiment goes, no difference in result was noted, whether the temperature was normal (72°), or at the freezing point (32°).

From the results of test seven it appears that it is not desirable to fumigate stock that is drenched with water, although in this test a trace of the gas was found in each sample drawn.

Columbus, Ohio.